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(54) **USER ACTIVITY TRACKING SYSTEM**

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(51) **Int. Cl.**

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H04L 29/08	(2006.01)
G06N 99/00	(2010.01)

(52) **U.S. Cl.**
CPC ***H04L 67/22*** (2013.01); ***G06N 99/005*** (2013.01)

(58) **Field of Classification Search**
CPC H04W 4/005; H04W 4/025; G06F 3/011; G06F 11/3438
See application file for complete search history.

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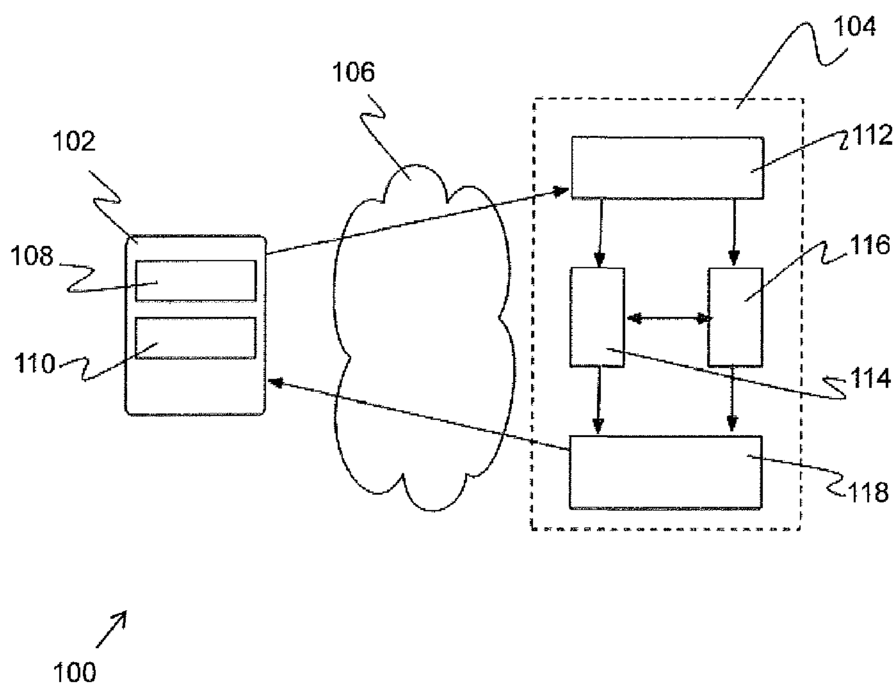
(57) **ABSTRACT**

In one embodiment, sensor signals corresponding to motions of a client computing device are received. The sensor signals are associated with activity periods, each activity period also being associated with a geographic location of the client computing device. For each activity period, one or more activity types are determined for the client computing device based on the sensor signals for the activity period and one or more signal parameters. A reference of the activity type and activity period is sent to the client computing device, and an indication is received regarding whether that reference is correct. The signal parameters may be adjusted based on the received indication.

20 Claims, 6 Drawing Sheets



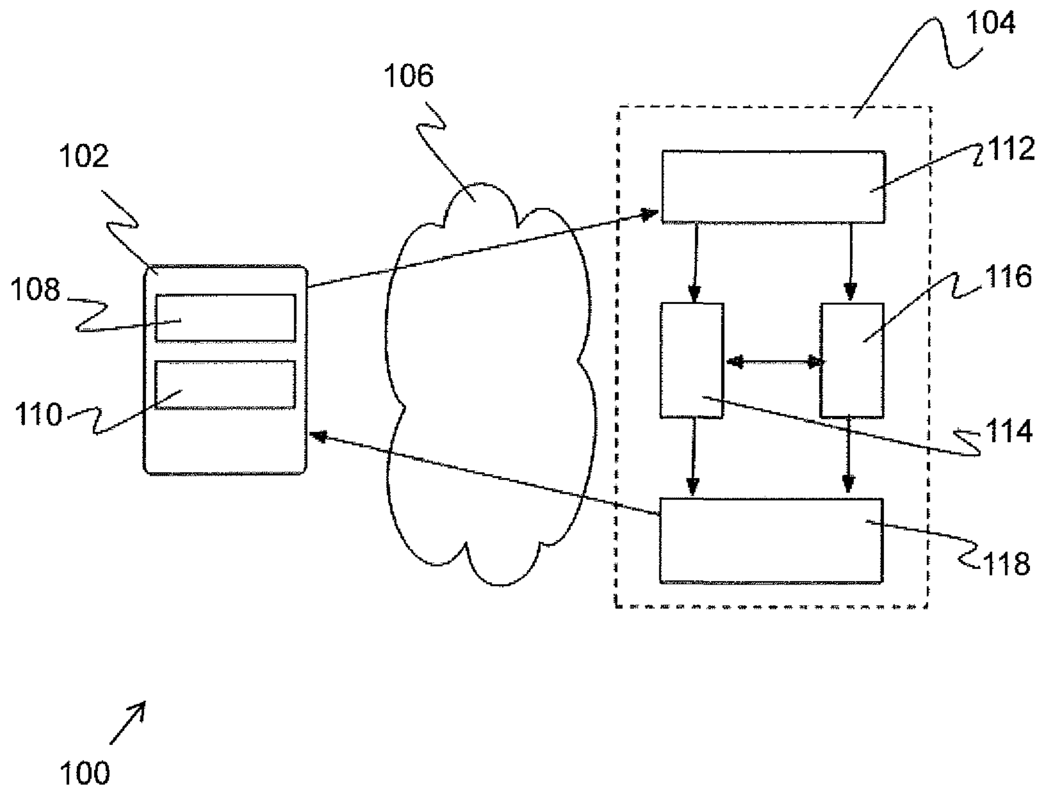


Fig. 1

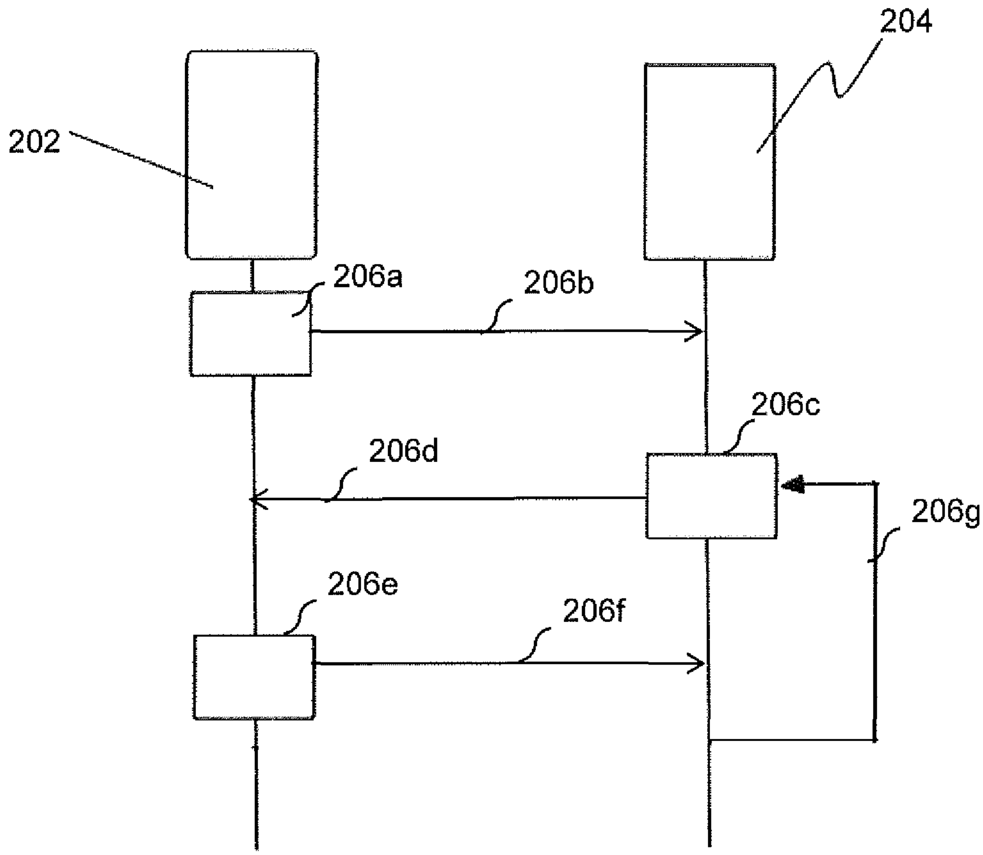


Fig. 2

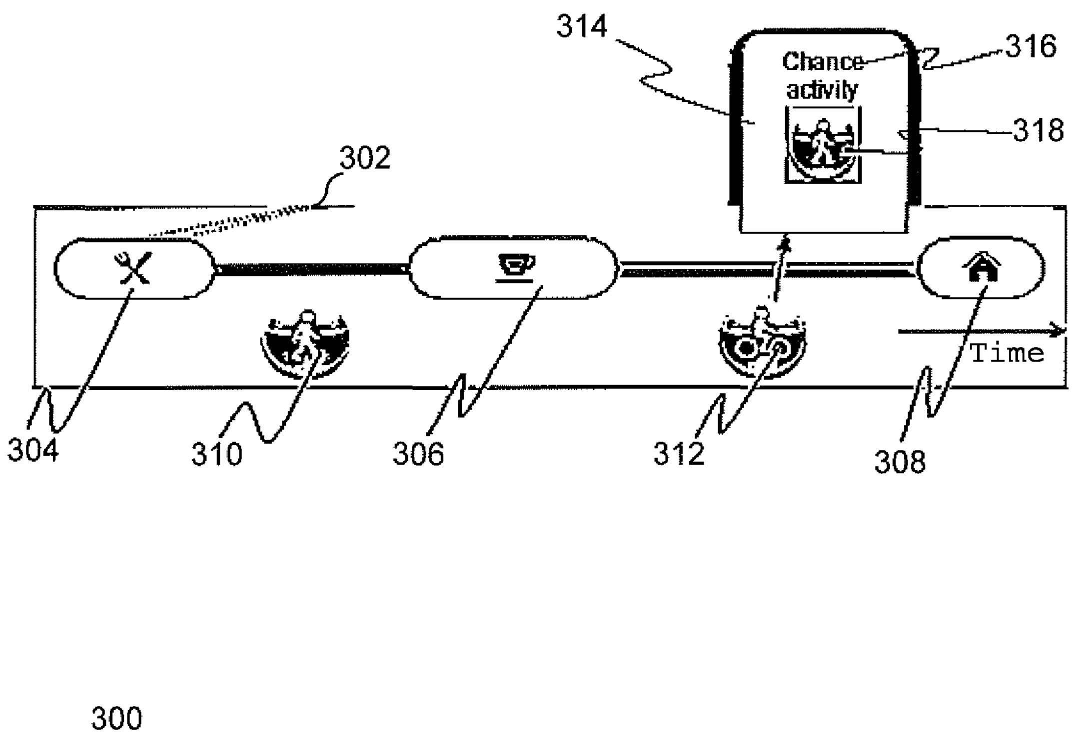


Fig. 3

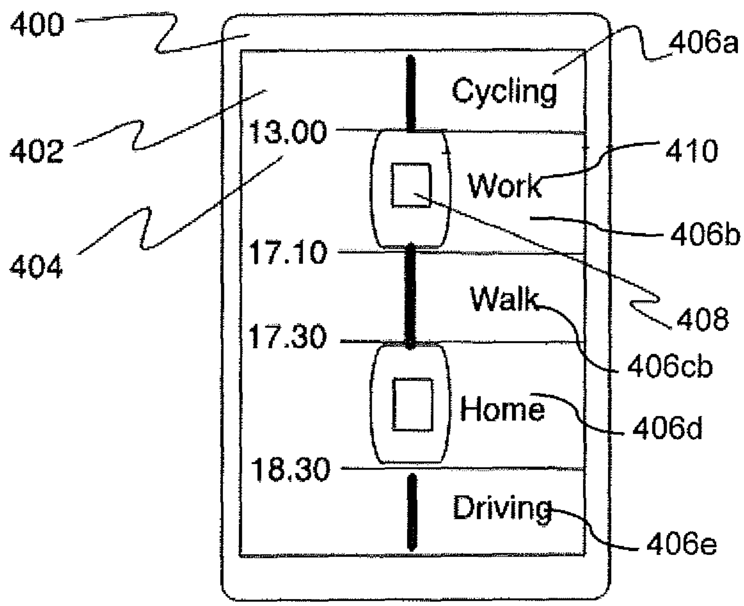
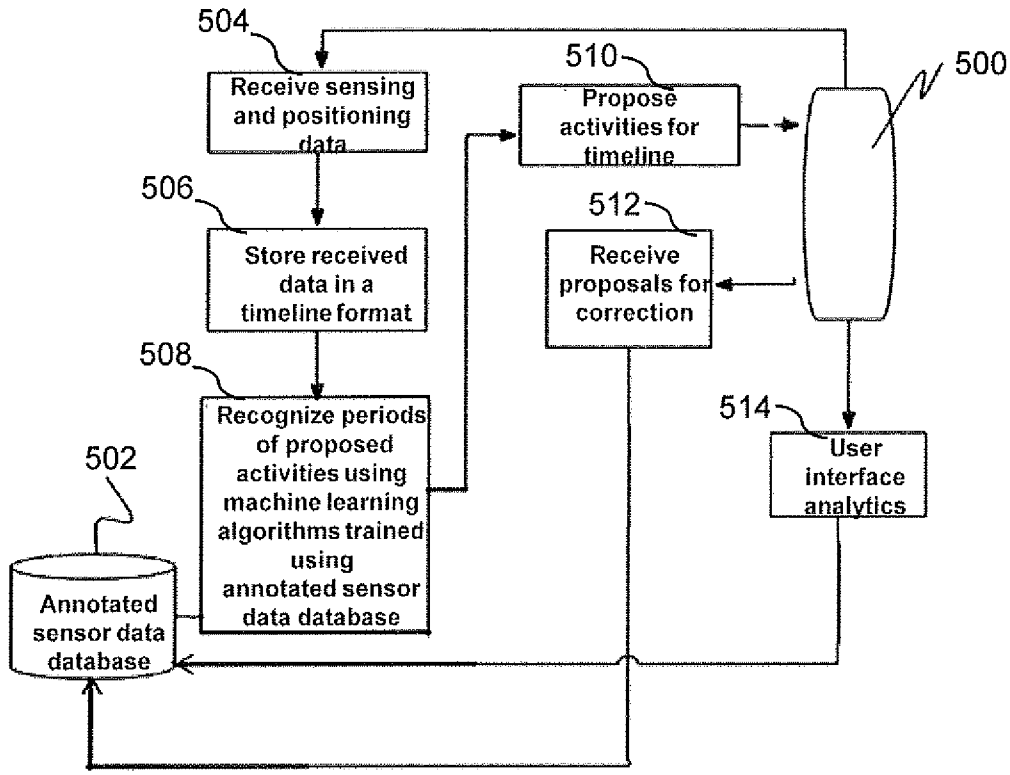

400
406a
Cycling
402
13.00
410
Work
404
406b
17.10
Walk
408
17.30
406cb
Home
406d
18.30
Driving
406e

Fig. 4



504
Receive sensing and positioning data
506
Store received data in a timeline format
508
Recognize periods of proposed activities using machine learning algorithms trained using annotated sensor data database
502
Annotated sensor data database
510
Propose activities for timeline
512
Receive proposals for correction
500
514
User interface analytics

Fig. 5

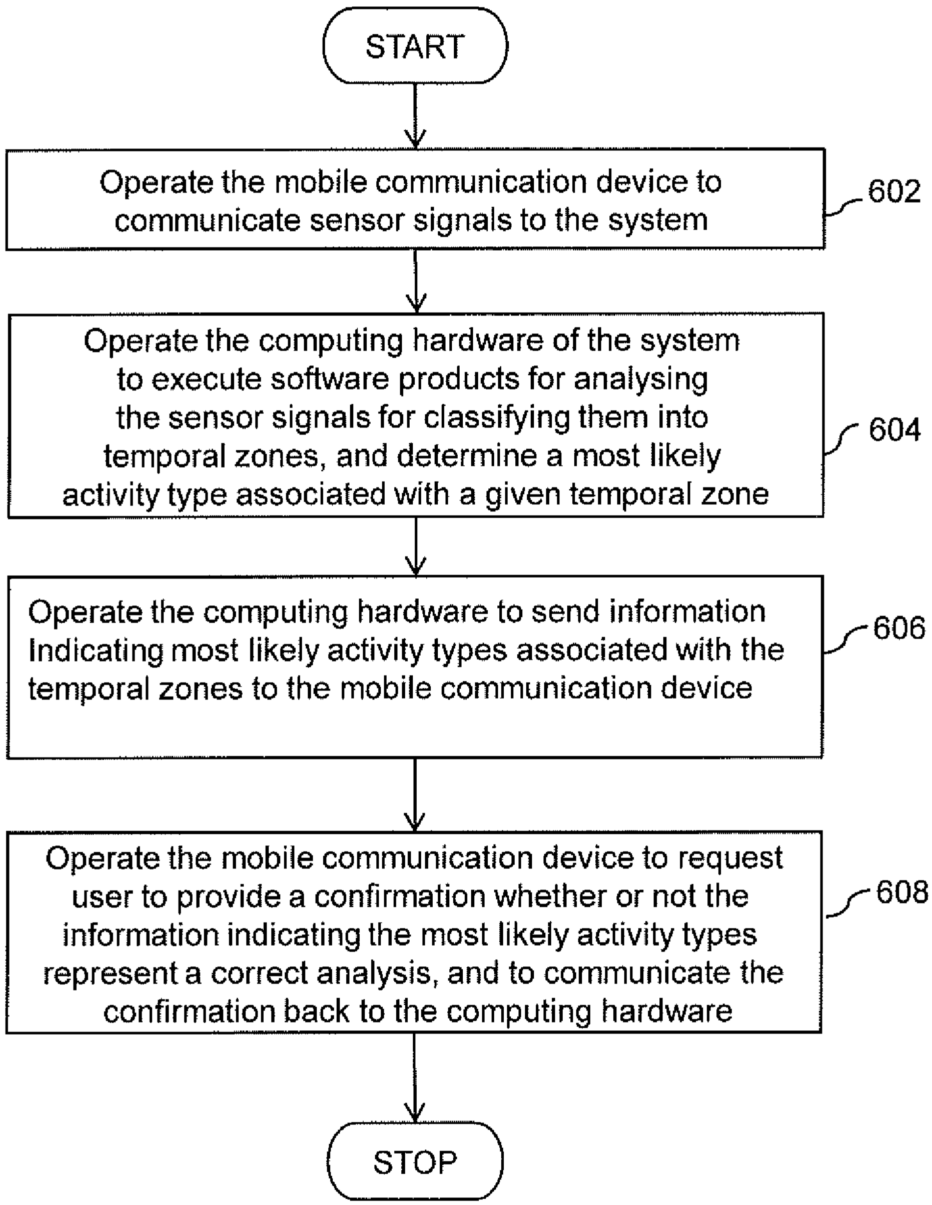

START
Operate the mobile communication device to communicate sensor signals to the system
602
Operate the computing hardware of the system to execute software products for analysing the sensor signals for classifying them into temporal zones, and determine a most likely activity type associated with a given temporal zone
604
Operate the computing hardware to send information Indicating most likely activity types associated with the temporal zones to the mobile communication device
606
Operate the mobile communication device to request user to provide a confirmation whether or not the information indicating the most likely activity types represent a correct analysis, and to communicate the confirmation back to the computing hardware
608
STOP

Fig.6

USER ACTIVITY TRACKING SYSTEM

RELATED APPLICATIONS

This application is a continuation under 35 U.S.C. §120 of U.S. patent application Ser. No. 13/930,321, filed 28 Jun. 2013.

This application is related to U.S. patent application Ser. No. 13/930,347, filed on 28 Jun. 2013, entitled USER ACTIVITY TRACKING SYSTEM AND DEVICE", the disclosure of which is incorporated herein by reference in its entirety.

FIELD

The present disclosure generally relates to tracking, recording and analyzing user activities, and more specifically to systems and methods for identifying user activities based on sensor data collected by a mobile communication device of the user. Moreover, aspects of the disclosure are also directed to software products recorded on non-transitory machine-readable data storage media, wherein such software products are executable upon computing hardware, to implement the methods of the disclosure.

BACKGROUND

Tracking devices are known that sense and track user activities, especially sports activities. An example of a known activity tracking device is a wearable wristwatch device with a GPS receiver for tracking and analyzing 'running' activity of an associated user. Another example is a mobile application that utilizes GPS system of a respective mobile phone for recording movement of users while they exercise. Another example is a step counter used in shoes or attached to the user's clothes to collect the number of steps taken by the user. However, none of the existing tracking devices automatically sense, record, analyze and identify all types of user activities such as walking, running, jogging, cycling, rowing, driving with car, moving with bus, moving with train, walking stairs, running stairs, jumping, swimming, playing football, and skiing.

Nowadays, smartphones are equipped with an increasing number of sensors such as Global Positioning System (GPS) receivers, accelerometers, and proximity sensors, and smartphone users may find it interesting to have mobile applications that can automatically record, sense, analyze, and identify their activities. However, one of the key challenges in the automatic tracking of users' movements for the purpose of analyzing the type of activity is the classification of activity types. For example walking vs running activity may have only small difference in respect to the collected sensor data. Moreover, for the same activity, the sensor data may vary depending on how the smart phone is carried by the user. For example, the smartphone may be carried by the user in his/her hand, or in a pocket or in a backpack.

Hence, there is a need for an activity tracking solution that accurately senses and analyzes all kinds of user activities and that addresses the limitations of existing activity tracking solutions.

SUMMARY

The present disclosure provides a system for tracking and recording movements of a mobile communication device and a method of the using the same.

In one aspect, embodiments of the present disclosure provide a system for tracking and recording movements of a mobile communication device that includes one or more movement sensors and a wireless interface. The system includes a communication network for communicating with the mobile communication device and computing hardware for processing data supplied in operation from the mobile communication device. The mobile communication device communicates sensor signals to the system, wherein the sensor signals are indicative of motion associated with activities to which the mobile communication device is exposed by its user.

The computing hardware executes software products for analyzing the sensor signals to classify them into one or more temporal zones, and for analyzing the signals within each given temporal zone to determine one or more most likely activity types associated with the given temporal zone. The computing hardware further sends information indicating the most likely activity types associated with the temporal zones to the mobile communication device. The mobile communication device then requests its user to provide a confirmation whether or not the information indicating the most likely activity types associated with a temporal zone represents a correct analysis, and then communicates the confirmation back to the computing hardware for amending parameters and/or algorithms employed in the software products, which execute analysis of the sensor signals to improve their accuracy.

The system generates a temporal log of activities experienced by the mobile communication device, and presents the activities on a graphical user interface of a user in a timeline format.

The mobile communication device is implemented by way of at least one of: a portable computer such as a laptop, a smartphone, a wrist-worn phone, a phablet, a mobile telephone, a tablet computer, a portable media device or any other computing device that can be worn by the user and is capable of processing and displaying data. Moreover, one or more sensors of the mobile communication device are implemented using at least one of: a gyroscopic angular sensor, an accelerometer, a GPS position sensor, a cellular position sensor (i.e. using position derived/calculated in relation to one or more radio basestations (cellular and local area), a magnetometer, a microphone, a camera, a temperature sensor.

When executed on the computing hardware, the software products are operable to implement supervised or semisupervised classification algorithms such as neural networks, decision forest, and support vector machines, for analysis of information included in the sensor signals. As input, the supervised or semisupervised classification algorithms can use, for instance, the amplitudes of the frequency components of the information included in the one or more sensor signals, and the output of the classification algorithms are estimated probabilities of different activities, conditional on the sensor signals.

In another aspect, the mobile communication device includes a data processor for executing a mobile software application thereat, wherein the mobile software application is operable to cause a graphical user interface of the mobile communication device to present analyzed activity results provided from the computing hardware in a form of a timeline, wherein different analyzed activities are represented by mutually different symbols in respect of the timeline.

In yet another aspect, embodiments of the present disclosure provide a method of using the system for tracking and recording the movements of the mobile communication device.

In yet another aspect, embodiments of the present disclosure provide a mobile communication device for implementing the system for tracking and recording movements of the user.

Embodiments of the present disclosure sense, analyze and identify all types of user activities by analyzing the data collected from one or more sensors of a mobile communication device of a user. The identified activities are displayed on a graphical user interface of the mobile communication device in a timeline format. If the user disagrees/agrees with an identified activity, then they may provide their feedback and the feedback may be used to improve the analysis and identification of the activities for the next time. Thus, the accuracy of the analysis and identification of the user activities is optimized over time.

Additional aspects, advantages, features and objects of the present disclosure would be made apparent from the drawings and the detailed description of the illustrative embodiments construed in conjunction with the appended claims that follow.

It will be appreciated that features of the invention are susceptible to being combined in various combinations without departing from the scope of the invention as defined by the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The summary above, as well as the following detailed description of illustrative embodiments, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the present disclosure, exemplary constructions of the disclosure are shown in the drawings. However, the invention is not limited to specific methods and instrumentalities disclosed herein. Moreover, those in the art will understand that the drawings are not to scale. Wherever possible, like elements have been indicated by identical numbers.

FIG. **1** is an illustration of a high-level architecture of a system that is suitable for practicing various implementations of the present disclosure;

FIG. **2** is an illustration of an exchange of information between a mobile communication device and a computing hardware of FIG. **1**, in accordance with the present disclosure;

FIG. **3** is an illustration of a graphical user interface (GUI) of the mobile communication device, in accordance with the present disclosure;

FIG. **4** is an illustration of an alternative layout of the GUI of the mobile communication device, in accordance with the present disclosure;

FIG. **5** is an illustration of steps of a method of determining activities of a user of a mobile communication device, in accordance with the present disclosure; and

FIG. **6** is an illustration of steps of using a system for tracking and recording movements of the mobile communication device, in accordance with the present disclosure.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

The following detailed description illustrates embodiments of the disclosure and ways in which it can be implemented. Although the best mode of carrying out the invention has been disclosed, those in the art would recognize that other embodiments for carrying out or practicing the invention are also possible.

The present disclosure provides a system for tracking and recording movements of a mobile communication device that

includes one or more movement sensors and a wireless interface. The system includes a communication network for communicating with the mobile communication device and computing hardware for processing data supplied in operation from the mobile communication device. The mobile communication device communicates one or more sensor signals to the system, wherein the sensor signals are indicative of motion associated with activities to which the mobile communication device is exposed by its user.

The computing hardware executes one or more software products for analyzing the sensor signals to classify them into one or more temporal zones, and for analyzing the signals within each given temporal zone to determine the most likely activity type associated with the given temporal zone. The computing hardware further sends information indicating the most likely activity types associated with the temporal zones to the mobile communication device. The mobile communication device then requests its user to provide a confirmation whether or not the information indicating the most likely activity types associated with the temporal zones represent a correct analysis, and then communicates the confirmation back to the computing hardware for amending parameters and/or algorithms employed in the software products that execute analysis of the sensor signals to improve their accuracy.

Referring now to the drawings, particularly by their reference numbers, FIG. **1** is an illustration of a high-level architecture of a system **100** that is suitable for practicing various implementations of the present disclosure.

The system **100** includes a mobile communication device **102**, and a server system **104** coupled in communication to the mobile communication device **102** by way of a communication network **106**. The mobile communication device **102** is a handheld device of a user, and examples of the mobile communication device **102**, include, but are not limited to, a smart phone, a wrist-worn phone, a phablet, a mobile telephone, a tablet computer executing operating systems such as Android, Windows, and iOS. The server system **104** includes a computing hardware that executes one or more software products for processing data supplied in operation from the mobile communication device **102**. The server system **104** can be arranged as a cloud service or as dedicated servers located in a single site or at a plurality of mutually spatially distributed sites. Moreover, examples of the communication network **106** include, but are not limited to, a telecommunication network, and a WIFI network.

The mobile communication device **102** includes one or more sensors **108** and one or more positioning systems **110** to determine the position, movement, acceleration and/or environment of the mobile communication device **102**, when a corresponding user performs one or more activities while carrying the device **102**. Examples of such one or more activities, include, but are not limited to, walking, running, jogging, cycling, rowing, driving a car, moving with bus, moving with train, walking stairs, running stairs, jumping, swimming, playing football, and skiing. An example of the sensor **108** includes a motion sensor configured to measure the acceleration of the mobile communication device **102** in xyz-directions of a Cartesian co-ordinate system. Further examples of the sensor **108** include a gyroscopic angular sensor, a magnetometer, a microphone, a camera, and a temperature sensor. The positioning systems **110** are configured to determine the position of the mobile communication device **102** by implementing at least one of GPS positioning system, cell tower information for cellular networks, indoor positioning systems, WIFI fingerprinting and proximal WiFi networks. In an embodiment of the present invention, the mobile communication device **102** may periodically send the information collected by the sensors **108** and the positioning systems **110** to the server system **104** via the communication network **106**.

The server system **104** includes a receiving module **112**, a first processing module **114**, a second processing module **116**, and an output module **118**. The receiving module **112** receives sensor and positioning data from the mobile communication device **102**. The first processing module **114** executes a first process to analyze sensor data collected from the sensors **108**, and the second processing module **116** executes a second process to analyze positioning data collected from the positioning systems **110**. In an embodiment of the present disclosure, the first and second processes are parallel processes that might communicate with each other and also exchange data for analysis purposes. Based on the sensor data, the first processing module **114** generates an activity type of the user, and based on the positioning data, the second processing module **116** generates location and movement information pertaining to the activity. The output module **118** processes the activity type information and movement/location information of the activity to generate a summary/schedule of activities of the user. The output module **118** then sends the summary of activities to the mobile communication device **102** over the communication network **106**.

The mobile communication device **102** includes a data processor (not shown) for executing a mobile software application thereat, wherein the mobile software application is operable when executed to cause a graphical user interface (GUI) of the mobile communication device to present summary of activities provided from the server system **104** in a timeline format. The user may send their positive/negative feedback on the summary of activities to the server system **104** and the server system **104** may receive, store and implement the feedback for improving their activity analysis.

In an embodiment of the present invention, some or all of the steps/analysis in the server system **104** may be implemented in the mobile communication device **102** based on the computing resources available in the mobile communication device **102**.

FIG. **1** is merely an example, which should not unduly limit the scope of the claims herein. One of ordinary skill in the art would recognize many variations, alternatives, and modifications of embodiments herein.

FIG. **2** is an illustration of an exchange of information between a mobile communication device **202**, and a server system **204** for tracking and analyzing activities of a user of the mobile communication device **202**, in accordance with the present disclosure. The mobile communication device **202** and the server system **204** are examples of the mobile communication device **102** and the server system **104** respectively, and have been explained in conjunction with FIG. **1**. A step **206*a*** takes place at the mobile communication device **202**, where the corresponding sensors and positioning systems measure sensor and positioning data when a corresponding user performs an activity. A step **206*b*** represents transfer of sensor and positioning data from the mobile communication device **202** to the server system **204** for analysis of the user activity. In an embodiment, the mobile communication device **202** may send the sensor and positioning data continuously or in a buffered format. In another embodiment, the mobile communication device **202** may send the sensor and positioning data to the server system **204** in a raw format. In yet another embodiment, the mobile communication device **202** may process sensor and positioning data before sending to the server system **204**. A step **206*c*** takes place at the server system **204**, where the server system **204** analyses the sensor and positioning data received from the device **202**. In an embodiment of the present invention, the server system **204** may perform analysis based on a supervised classification and/or other machine learning algorithms and form a summary of activities of the user. A step **206*d*** represents communication of summary of activities from the server system **204** to the mobile communication device **202**. A step **206*e*** takes place at the mobile communication device **202**, where the summary of activities is displayed on a graphical user interface (GUI) of the mobile communication device **202**. A step **206*f*** represents a transfer of positive/negative feedback of the user on the summary of activities to the server system **204**. Lastly, a step **206*g*** represents implementation of the feedback by the server system **204** by modifying parameters and/or to selecting training data for the machine learning algorithms for providing a more accurate summary of activities in future. Examples of machine learning algorithms, for activity monitoring include, but are not limited to, supervised or semisupervised classification algorithms such as neural networks, decision forest, and support vector machines. The feedback is provided as an input to the machine learning algorithms and is used to modify parameters and select training data for the machine learning algorithms.

FIG. **2** is merely an example, which should not unduly limit the scope of the claims herein. One of ordinary skill in the art would recognize many variations, alternatives, and modifications of embodiments herein.

FIG. **3** is an illustration of a graphical user interface (GUI) **302** of the mobile communication device **200**, in accordance with the present disclosure, and has been explained in conjunction with FIG. **2**.

The GUI **302** displays the summary of activities of a user (received from the server system **204** at the step **206*d***) in a time line format. In an exemplary embodiment, the GUI **302** displays location of the user by three location symbols, i.e. a restaurant symbol **304**, a cafeteria symbol **306** and a home symbol **308**, indicating that the user has visited the restaurant, cafeteria and home one after the other. The locations represented by the graphical symbols **304**, **306** and **308** are identified based on the GPS system of the mobile communication device **202**, cell tower information for cellular networks, indoor positioning systems, proximal WiFi, and/or WiFi fingerprinting. The GUI **302** further displays activities performed by the user by respective graphical symbols. In an example, a 'walking' activity symbol **310** is displayed between the restaurant **304** and cafeteria **306** to indicate that the user has walked from the restaurant to cafeteria. Further, a 'cycling' activity symbol **312** is displayed between the cafeteria **306** and the home **308** to indicate that the user has cycled from the cafeteria to home.

The story line display **302** may be a touch screen display and may be configured in a manner such that when a user touches or points an activity indication symbol such as the 'cycling' activity symbol **312**, or a line above or an area close to the symbol **312**, a pop-up menu **314** is presented. The pop-up menu **314** includes a text field **316** for enabling the user to modify the activity and a symbol field **318** for enabling the user to modify the graphical symbol pertaining to the activity. Similarly when a user touches or points a location symbol such as the 'restaurant' symbol **304**, or a line above or an area close to the symbol **304**, a pop-up menu (not shown) may be presented to modify the location. The modification of location/activity symbol by the user is communicated to the server system **204** as a feedback (step **206*f***).

FIG. **3** is merely an example, which should not unduly limit the scope of the claims herein. One of ordinary skill in the art would recognize many variations, alternatives, and modifications of embodiments herein.

FIG. **4** is an illustration of a graphical user interface (GUI) **402** of a mobile communication device **400**, which is an example of the mobile communication device **200**, and has been explained in conjunction with FIGS. **2** and **3**. The GUI **402** is an alternate layout of the GUI **302**. The GUI **402** displays a time line **404** that is divided into 'activity' zones/periods **406***a*, **406***b*, **406***c*, **406***d* and **406***e*, hereinafter collectively referred to as activity zones **406**, based on start and end time of one or more activities. Each activity zone **406** illustrates an activity and corresponding location of the activity. Further, each activity zone **406** may be illustrated by a graphical symbol **408** or a text description **410** of the corresponding activity.

In an exemplary embodiment, the timeline **404** indicates that at 13:00 pm, a 'cycling' activity of user ends and he/she is stationed at a 'workplace' until 17:10 pm; at 17:10 pm, the user starts a 'walking' activity towards home; at 17:30 pm, the user reaches home and is at home until 18:30 pm; at 18:30 pm, the user starts a 'driving' activity.

FIG. **4** is merely an example, which should not unduly limit the scope of the claims herein. One of ordinary skill in the art would recognize many variations, alternatives, and modifications of embodiments herein.

FIG. **5** is an illustration of steps of a method of determining activities of a user of a mobile communication device **500**, in accordance with the present disclosure. The user activities are determined by an analysis logic module (not shown) which is supplied with the sensor and positioning data generated in operation by the mobile communication device **500**, and an annotated sensor data database **502**. The analysis logic module is communicatively coupled to the annotated sensor data database **502**. In an embodiment of the present invention, the analysis logic module and the annotated sensor data database **502** may be present inside a remote server system. In another embodiment of the present invention, the analysis logic module and the annotated sensor data database **502** may be present inside the mobile communication device **500** itself.

At a step **504**, the analysis logic module receives sensor and positioning data of the user from sensor and positioning systems of the mobile communication device **500**. At a step **506**, the analysis logic module stores the sensor and positioning data in a time line format in the annotated sensor data database **502**, i.e. the sensor and positioning data is time stamped to record time and date of each or some of the collected data items. The annotated sensor data database **502** includes sensor and positioning data received from the mobile communication device **500**, annotated with the information from user feedback on corresponding previously identified activities.

At a step **508**, the analysis logic module analyzes the time line and delineates one or more activity periods and recognizes user activities in each activity period using different types of machine learning algorithms, which are trained using the data stored in the annotated sensor data database **502**. For accurately identifying the activities, the analysis logic module may classify the annotated sensor and positioning data based on type of user, type of mobile device, type of user group, type of mobile device group, and demographic factors, etc. to take into account of environments and individual characteristics of the users. For example, acceleration data sensed by an accelerometer of the mobile communication device **500** for an active athletics specialized in long distance running may be different from the acceleration data sensed for a casual runner running very seldom. The active athletics may have longer steps with more predictable frequency between steps with lower variation of the frequency, than the casual runners. Therefore, for similar sensed data, the activity type may differ based on type of user group. Further, some mobile communication devices might have higher accuracy than others, therefore, for similar sensed data, the activity type may differ based on type of mobile communication device. The demographic classification may refer to segmenting users based on their gender, age, place of living etc, as the sensor data for a same activity might vary from person to person. The analysis logic module may further weigh the classified sensor data to take into consideration user specific features i.e. data could have weighted element consisting of average data from all users and user specific element from certain user based on the usage history.

At a step **510**, the analysis logic module may use the classified sensor data to make a time line of the user activities, and communicate the time line to the mobile communication device **500**. The mobile communication device **500** may display the time line on a user interface of the device **500**. At a step **512**, the analysis logic module may receive proposals for correcting one or more user activities in the timeline, from the mobile communication device **500**. The proposals for correcting the user activities may be provided to the annotated sensor data database **502** for training of the machine learning algorithms.

At a step **514**, the mobile communication device **500** may monitor whether or not the proposed time line has been viewed by the user using user interface analytics. If the user has viewed the proposed time line but not provided any correction in any activity of the timeline, then no feedback may be considered as positive feedback and is updated in the annotated sensor data database **502** that the analysis of one or more activities was correct and may be used as a training data for the algorithms. Further, if the user has viewed a storyline/timeline of a certain day and has been active in making corrections, one can conclude that that the recognized activities, which the user has not changed in the storyline, are probably considered to be correct and may be used as a training data for the algorithms. Further, it can be concluded that the recognized activities, which the user has changed in the storyline, are probably not correct. The amount of corrections made by users to certain activity can be used as a measure of recognition accuracy in regard to that activity. In the annotated sensor data database **502**, the sensor data may be labeled, with a certain confidence of the labeling, based on the annotations containing information about user feedback on the corresponding proposed activities.

In an embodiment of the present invention, the analysis logic module may implement a first machine learning algorithm for determining user activities based on the sensor and positioning data, and newly introduce a second machine learning algorithm. However, if the data analyzed based on the second algorithm is more accurate than the data analyzed by the first algorithm, then the second algorithm may be determined to be priority algorithm over the first algorithm. This feature enables to test different setups and get "votes" on the capability of a machine learning algorithm.

It should be noted here that the steps **504** to **514** are only illustrative and other alternatives can also be provided where one or more steps are added, one or more steps are removed, or one or more steps are provided in a different sequence without departing from the scope of the claims herein.

FIG. **6** is an illustration of steps of using the system **100** for tracking and recording movements of the mobile communication device **102**, in accordance with the present disclosure, and has been explained in conjunction with FIGS. **1** and **2**.

The method is depicted as a collection of steps in a logical flow diagram, which represents a sequence of steps that can be implemented in hardware, software, or a combination thereof.

At a step **602**, the mobile communication device **102** is operable to communicate one or more sensor signals to the server system **104**, wherein the sensor signals are indicative of motion associated with activities to which the mobile communication device **102** is exposed by its user. The sensor signals are output of one or more sensors of the mobile communication device **102**.

At a step **604**, the computing hardware of the server system **104** is operable to execute one or more software products for analyzing the sensor signals to classify them into one or more temporal zones, hereinafter referred to as activity zone, and for analyzing the sensor signals within each activity zone to determine a most likely activity type associated with the activity zone.

At a step **606**, the computing hardware is operated to send information indicating one or more most likely activity types associated with the one or more activity zones to the mobile communication device **102**.

At a step **608**, the mobile communication device **102** is operable to request its user to provide a confirmation whether or not the information indicating the most likely activity types represent a correct analysis, and to communicate the confirmation back to the computing hardware for amending parameters and/or algorithms employed in the software products which execute analysis of the sensor signals to improve their accuracy.

It should be noted here that the steps **602** to **608** are only illustrative and other alternatives can also be provided where one or more steps are added, one or more steps are removed, or one or more steps are provided in a different sequence without departing from the scope of the claims herein.

Although embodiments of the current invention have been described comprehensively, in considerable detail to cover the possible aspects, those skilled in the art would recognize that other versions of the invention are also possible.

What is claimed is:

1. A method comprising:

by one or more computing devices, receiving from a client device one or more sensor signals corresponding to one or more motions of the client device;

by one or more computing devices, determining one or more activities of a user, wherein the user corresponds to the client device, wherein the determining comprises:

associating each of the one or more sensor signals with one or more activity periods, each activity period comprising a geographic location of the client device; and

for each of the one or more activity periods, selecting one or more activity types corresponding to each activity period based on the associated sensor signals and one or more signal parameters;

by one or more computing devices, sending a reference to the activity types and activity periods to the client device;

by one or more computing devices, receiving an indication from the client device of whether the reference is correct; and

by one or more computing devices, determining whether to adjust the signal parameters based on the indication.

2. The method of claim **1**, wherein the reference comprises a timeline of activity periods experienced by the client device.

3. The method of claim **2**, wherein the timeline comprises: an indication of the activity types for each activity period; and one or more locations associated with each activity period.

4. The method of claim **1**, wherein the client device comprises: a portable computer; a portable media device; a smart phone; a wrist-worn phone; a mobile telephone; or a tablet computer.

5. The method of claim **1**, wherein the sensor signals are provided by one or more sensors of the client device, the sensors comprising: a gyroscopic angular sensor; an accelerometer; a GPS position sensor; a radio network based position sensor; a magnetometer; a microphone; a camera; or a temperature sensor.

6. The method of claim **1**, wherein selecting the activity types comprises: a supervised or semisupervised classification analysis of the sensor signals; or a heuristic analysis of the sensor signals.

7. The method of claim **6**, wherein the supervised or semisupervised classification analysis comprises a classification algorithm to measure one or more frequency components of the information included in the one or more sensor signals for determining the amplitudes of the one or more frequency components at different points in time, wherein the amplitudes are used as input parameters in the supervised classification analysis or heuristic analysis.

8. The method of claim **1**, wherein the sensor signals are received from the client device continuously.

9. The method of claim **1**, wherein the sensor signals are received from the client device at predetermined time intervals.

10. The method of claim **1**, wherein the signal parameters are adjusted by a machine learning algorithm based on the indication.

11. The method of claim **1**, wherein the indication comprises a correction of the reference by a user of the client device, and the signal parameters are adjusted based on the correction.

12. The method of claim **11**, wherein the correction comprises a correction to the location associated with an activity period of the reference.

13. The method of claim **11**, wherein the correction comprises a correction to the activity types corresponding to an activity period of the reference.

14. The method of claim **11**, wherein the correction comprises a correction to the time period corresponding to an activity period of the reference.

15. The method of claim **1**, wherein if the indication comprises data indicating that a user of the client device has viewed the reference, but no feedback has been received from the client device, then the reference is determined to be correct.

16. The method of claim **1**, wherein the sensor signals are classified based on characteristics of the client device and one or more users associated with the client device.

17. The method of claim **16**, wherein the characteristics comprise: a demographic classification of the users; a device type of the client device; an activity level of the users; or one or more groups associated with the users.

18. The method of claim **16**, wherein the activity type is selected based on the classification of the sensor signals.

19. A system comprising:

one or more processors; and

a memory coupled to the processors comprising instructions executable by the processors, the processors operable when executing the instructions to:

receive from a client device one or more sensor signals corresponding to one or more motions of the client device;

determine one or more activities of the user, wherein the user corresponds to the client device, wherein the determining comprises:

associating each of the one or more sensor signals with one or more activity periods, each activity period comprising a geographic location of the client device; and

for each of the one or more activity periods, selecting one or more activity types corresponding to each activity period based on the associated sensor signals and one or more signal parameters;

send a reference to the activity types and activity periods to the client device;

receive an indication from the client device of whether the reference is correct; and

determine whether to adjust the signal parameters based on the indication.

20. One or more computer readable non-transitory storage media embodying software that is operable when executing on a computing device to:

receive from a client device one or more sensor signals corresponding to one or more motions of the client device;

determine one or more activities of the user, wherein the user corresponds to the client device, wherein the determining comprises:

associating each of the one or more sensor signals with one or more activity periods, each activity period comprising a geographic location of the client device; and

for each of the one or more activity periods, selecting one or more activity types corresponding to each activity period based on the associated sensor signals and one or more signal parameters;

send a reference to the activity types and activity periods to the client device;

receive an indication from the client device of whether the reference is correct; and

determine whether to adjust the signal parameters based on the indication.

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